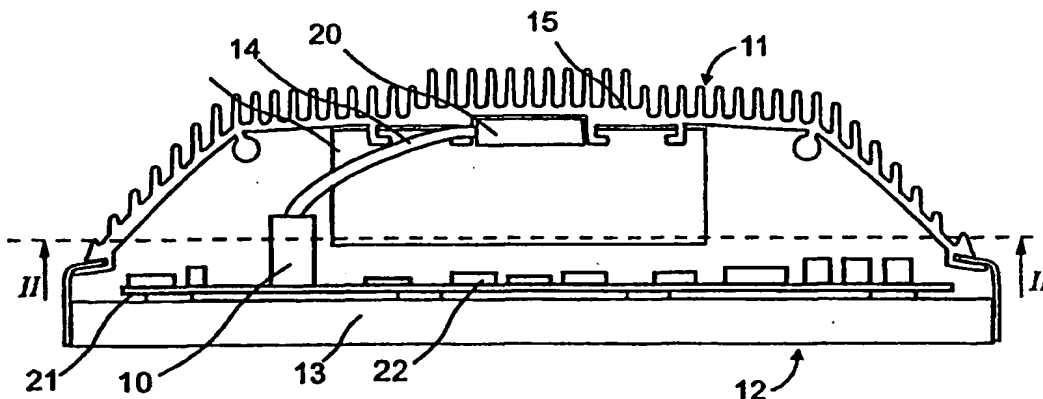




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: COMPUTER COOLING DEVICE



## (57) Abstract

Cooling device in an electric apparatus comprising a cover having a bottom plate (16), an upper part (17), a rear side (11), and an opposite front side (12) essentially covered by a flat display (13), at least one a large amount of heat emitting component (10) being provided within said cover, at least a section of said cover being formed as a cooling plate (15). A first end of said heat-conducting pipe (14) is in heat-conducting contact with said component (10), and a second end of said heat-conducting pipe (14) is in heat-conducting contact with said cooling plate (15). The invention also relates to a method for cooling an electric apparatus, wherein heat from a component (10) arranged within a cover is transported from said component (10) through a heat-conducting duct (14) to the exterior of the cover. The transport of heat is made without any addition of energy. In a computer according to the invention at least a section of a cover is formed as a cooling plate (15). A heat-conducting duct (14) is provided between said component (10) and said cooling plate (15), so as to cool off said component (10) without any contribution from a fan means.

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COMPUTER COOLING DEVICE

## TECHNICAL ART

5           The invention relates to a computer cooling device comprising a cover having a bottom plate, an upper part, a rear side and an opposite front side covered essentially by a flat display, at least one a large amount of heat emitting component being provided within said cover. The invention relates first of all to flat electronic devices with electronic components in a compact design. One embodiment includes flat display units having an embedded  
10           computer.

## BACKGROUND ART

15           Electronic devices are available in more and more compact design resulting in a cooling problem. Personal computers and similar devices are normally provided with ventilation apertures in the cover of the computer and a fan producing a desired flow of air within the cover. Modern processors working at ever increasing operating frequencies sometimes require further  
20           cooling, for instance by an arrangement with a fan directly over the processor. The processor and several other components included in a computer are normally provided on a circuit board or similar device.

          In computers and other electronic devices that are in flat form there are problems related to the cooling of heat emitting electronic components.  
25           Thus, there is a demand for an improvement of the cooling performance in these types of electronic products in the first place. In the field of electronics it is normal that such components that emit large amounts of heat, such as processors and power semiconductors, are provided with finned cooling elements. In such embodiments the cooling element is in direct contact with  
30           the component which in for instance computer devices means that a fan is required so as to cool the cooling element within a cover.

The fan that is required for the cooling will produce an undesired sound. Fans that are ever more silent have been developed so as to decrease the sound level. It is also more common that the fan is temperature controlled, so as to be active only when the temperature in a measured object extends over a certain value.

In some office environments and also in other connections there is an increased interest for and a demand for computers that are even more silent. At the same time the processor frequency and the data capacity increase and the size of the computers decreases making the possibilities to cool more difficult.

An object of the invention is to provide a cooling device that operates with a good efficiency also at a low sound level. This object is achieved by an invention having the characteristic features of claim 1. Further objects and advantages with the invention are apparent from the following description, drawings and dependent claims.

## DISCLOSURE OF INVENTION

The invention relates to a cooling device preferably for use in connection with compact computers. Such computers include a cover having a bottom plate, an upper part, a rear side and an opposite front side mainly covered by a flat display, at least one component emitting a high level of heat being provided within the cover.

According to the invention at least one section of the rear side of the cover is formed as a cooling fin. A first end of a heat-conducting pipe is arranged in a heat conducting contact with the component and a second end of the heat-conducting pipe is arranged in a heat conducting contact with the cooling element.

A heat-conducting pipe, also referred to as a heat pipe, is a completely sealed tube made of a heat conducting material, such as copper or an alloy.

One or a plurality of apertures or channels extend axially in the tube. A wick or another material or other means that is able to transport a liquid by the capillary effect also extends axially. The tube is evacuated and then filled with a liquid to such a level that vapor inside is at saturation conditions and that liquid is close to condensation. The ends of the tube are sealed.

One of the ends of the tube is arranged in a heat conducting contact with the object that is to be cooled and cooling of some type is provided at the other end of the tube. In the hot end of the tube liquid will vaporize. As a result of the vapor pressure and temperature potential gradient that will develop in the tube vapor will flow against the cooler end of the tube where the vapor is condensed into liquid. The liquid is transported through the capillary effect or a corresponding way back to the hotter end of the tube where it is evaporated again. The heat transfer between the ends of the tube is very rapid and efficient. As a result of the strong forces on the liquid and the vapor within the tube the tube is essentially not influenced by gravity.

According to the invention heat is transported away from heat generating components, mainly the processor of the computer, to a cooling element and the exterior of the computer. Thus, heat is not conducted to a cooling apparatus, such a fan within the computer.

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### BRIEF DESCRIPTION OF DRAWINGS

The invention will now be described in more detail by means of embodiments, reference being made to the accompanying drawings, in which

Fig. 1 is cross sectional view of a cooling device in accordance with the invention,

Fig. 2 is an elevation sectional view from the line II-II of the cooling device in Fig. 1, and

Fig. 3 is a schematic prospective view in an inclined angle from behind of an alternative embodiment of a cooling device in accordance with the invention.

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## DETAILED DESCRIPTION

Fig. 1 shows schematically a so called "flat panel computer", that is a computer integrated with a flat display. The computer includes a plurality of electric and electronic components, many of which generating a lot of heat.

10 At least one specifically heat emitting component 10 is provided inside a cover enclosing the computer. Normally a processor circuit constitutes the most heat emitting component. The cover comprises a backside 11 and a front side 12. The front side 12 is essentially covered by a display 13. The cover comprises also a bottom plate and an upper part, see Fig. 1.

15 The rear side 11 comprises at least one section formed by a fined cooling plate 15. In the embodiment shown said cooling plate 15 covers the complete backside but also other embodiments are possible. A vertical central section of the backside can for instance be covered by or constitute a cooling plate. The heat emitting component 10 is connected to the cooling  
20 plate 15 through a heat conducting tube 14 of the type described above. Preferably the heat conducting tube 14 is connected through connecting sections 20 so as to accomplish a good heat transfer from the heat conducting tube 14 to the cooling plate 15 and from the component 10 to the heat conducting tube, respectively. The heat conducting tube 14 can in some  
25 embodiments be replaced by a block or a bar made of an extremely well heat conducting material, such as aluminum.

In the space between the display 13 and the backside of the computer a circuit board 21 is provided. In a conventional manner the circuit board 21 is provided with a plurality of electronic and electric components 22. Also  
30 these components require cooling and in accordance with one aspect of the invention such a cooling is provided by providing an air intake section 18 in

the bottom plate of the cover. In the embodiment shown the air intake section 18 is formed as one larger opening, but it is possible also to provide a plurality of smaller openings.

5 Preferably the air intake section 18 extends to the backside to make an air flow formed by natural draft to pass by along the cooling plate 15 and to cool this off. An air outlet section 19 is provided in the upper part 17, see Fig. 2, so as to allow the natural draft to develop.

Fig. 2 shows schematically the inner side of the cooling plate 15 and the connection section 20 connected to the cooling plate 15. The heat-  
10 conducting tube 14 to some extent is bent down towards the connection against the heat emitting component 10. In this way the return flow of liquid after condensation in the cooler end of the heat-conducting pipe 14 will be facilitated.

A bottom plate 16 covers the complete lower side of the computer and  
15 is provided with apertures 18 forming the air intake section 18. In a corresponding way apertures 23 are formed in an upper part 17 covering the upper side of the computer. These apertures form the air outlet section 19. The air flow passing through between said air intake section 18 and said air outlet section 19 is comparatively large and will produce a good cooling effect. The  
20 total area of the air intake section 18 and the air outlet section 19, respectively, also should be comparatively large.

Fig. 3 shows schematically one embodiment of a computer being provided with a cooling device in accordance with the invention. The entire rear side 11 of the computer is covered by a cooling plate 15. The upper part 17  
25 is made from plastic or a similar material and a plurality of apertures 23 are formed therein, said apertures forming the air outlet section 19. The air intake section 18 in the bottom plate 16 is indicated by dashed lines. Also the bottom plate 16 can be formed of plastic or a similar material.

## CLAIMS

1. A cooling device in an electric apparatus comprising a cover having a bottom plate (16), an upper part (17), a rear side (11) and an opposite front side (12) essentially covered by a flat display (13), at least one a great quantity of heat emitting component (10) being provided within said cover, characterized in
- 5 that at least one section of the cover is formed as a cooling plate (15),  
that a first end of a heat-conducting pipe (14) is provided in a heat-conducting contact with said component (10), and
- 10 that a second end of said heat-conducting pipe (14) is provided in a heat-conducting contact with said cooling plate (15).
2. Cooling device according to claim 1, wherein said cooling plate (15) is
- 15 provided at the rear side (11).
3. Cooling device according to claim 1, wherein said bottom plate (16) is formed with at least one air intake section (18) and said upper part (17) is formed with at least one air outlet section (19) arranged vertically above said
- 20 air intake section (18).
4. Cooling device according to claim 1, wherein said cooling plate (15) is provided with vertically extending external cooling fins.
- 25 5. Cooling device according to claim 1, wherein said air intake section (19) is formed by a plurality of apertures (23) made in the upper part (17).
6. Cooling device according to claim 1, wherein said heat-conducting pipe (14) is connected to the cooling plate (15) at a level above the connection of
- 30 the heat-conducting pipe (14) to the component (10).

7. Cooling device according to claim 1, wherein said cooling plate (15) is made of aluminum.

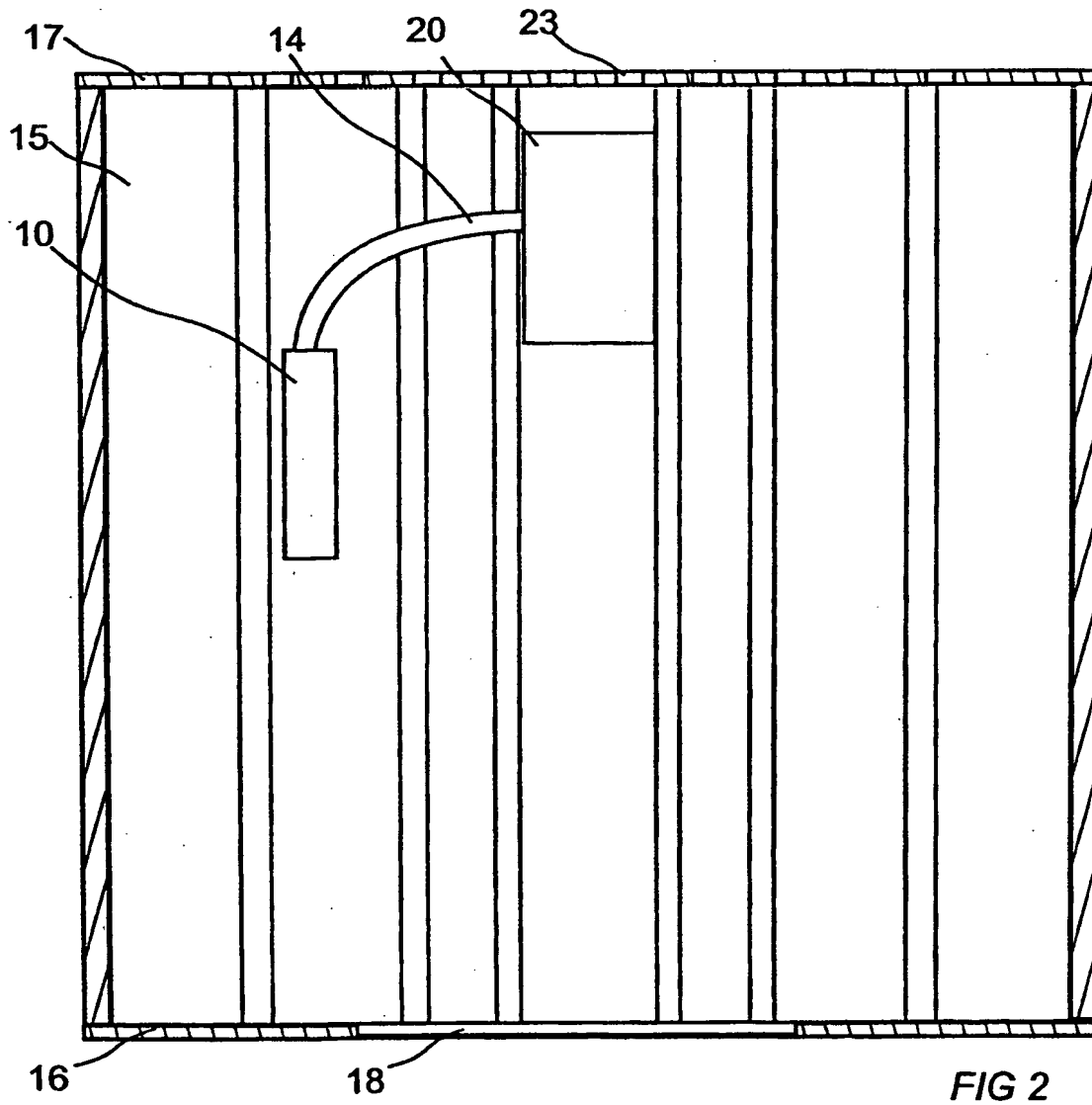
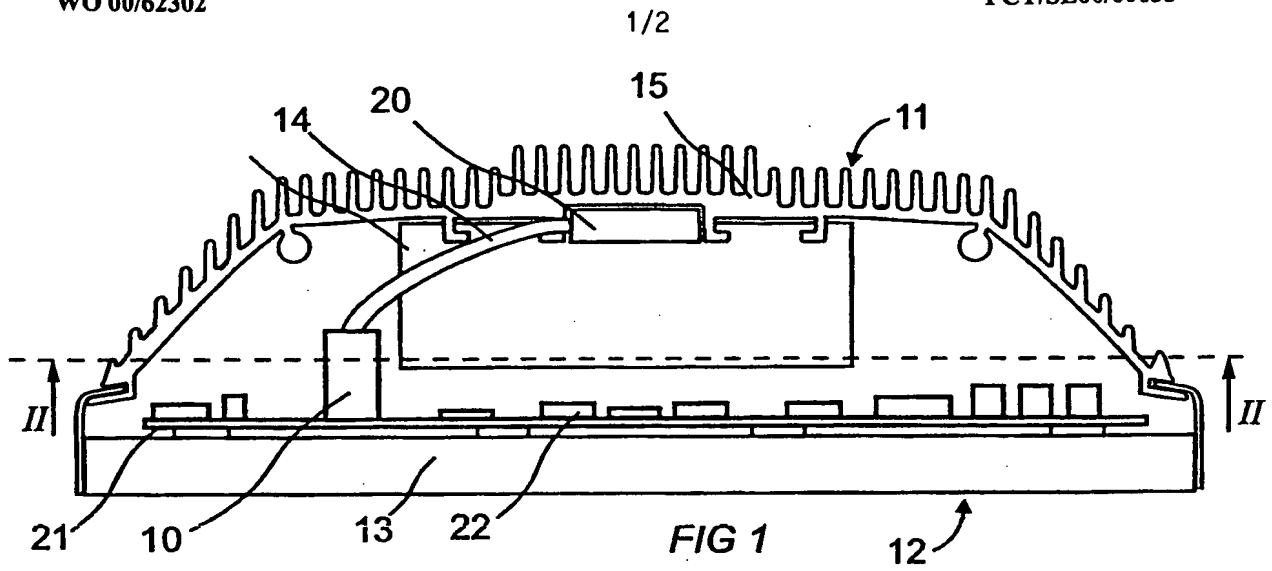
8. A computer comprising a cover having a bottom plate (16), an upper part (17), a rear side (11) and an opposite front side (12) essentially covered by a flat display (13), at least one a large amount of heat emitting component (10) being provided within said cover, characterized in that at least a section of said cover being formed as a cooling plate (15), and that a heat-conducting duct (14) is provided between said component (10) and said cooling plate (15), so as to cool said component (10) without contribution of any fan means.

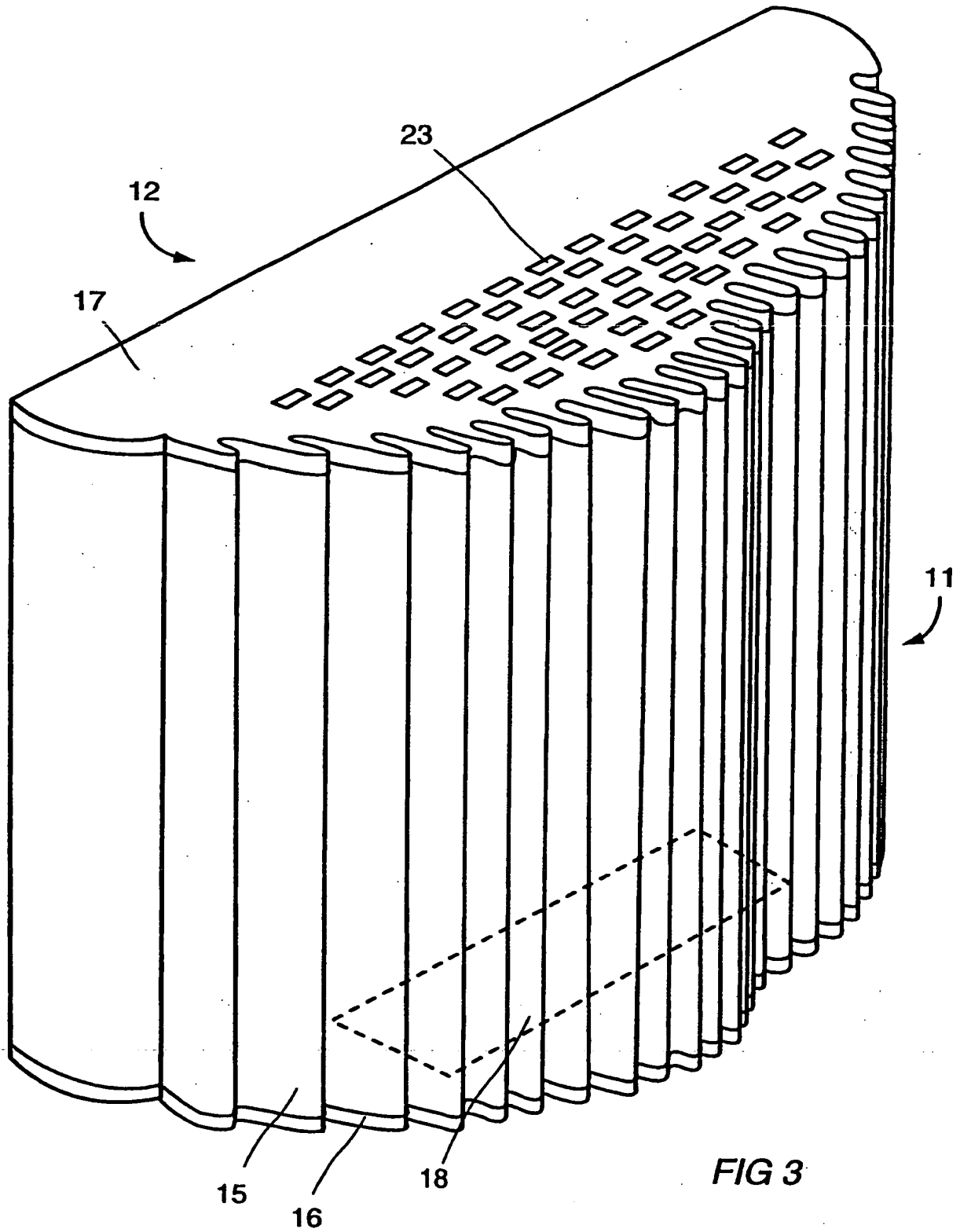
9. A method for the cooling of an electric apparatus, characterized by transporting heat from a heat emitting component (10) arranged within a cover from said component (10) through a heat-conducting duct (14) to the exterior of said cover and by transporting said heat without an additional supply of energy.

10. A method according to claim 9, wherein the heat is transported without a contribution of a fan means.

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## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G12B 15/06, H05K 7/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

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IPC7: G12B, H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
| X         | US 5875095 A (WEBB), 23 February 1999 (23.02.99),<br>column 5, line 7 - line 60, figures 1-4,<br>abstract<br><br>--   | 1-10                  |
| X         | US 5781409 A (MECREDY III), 14 July 1998<br>(14.07.98), column 4, line 38 - column 5, line 10;<br>column 6, line 22 - line 52, figures 1-4,<br>abstract<br><br>-- | 1-10                  |
| A         | US 5339214 A (NELSON), 16 August 1994 (16.08.94),<br>column 2, line 60 - column 3, line 7, figures 1-3,<br>abstract<br><br>-----                                  | 1-10                  |

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

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| Patent document<br>cited in search report |         |   | Publication<br>date |  | Patent family<br>member(s) | Publication<br>date |
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